Amendments to the Claims

Please amend Claims 36, 39, 47, 51 and 56. The Claim Listing below will replace all prior versions of the claims in the application:

Claim Listing

1. (Original) A composite gas separation module, comprising:
   a) a porous metal substrate;
   b) an intermediate porous metal layer, wherein the intermediate porous metal layer overlies the porous metal substrate; and
   c) a dense hydrogen-selective membrane, wherein the dense hydrogen-selective membrane overlies the intermediate porous metal layer.

2. (Original) The composite gas separation module of Claim 1 wherein the porous metal substrate is stainless steel.

3. (Original) The composite gas separation module of Claim 1 wherein the porous metal substrate is an alloy containing chromium and nickel.

4. (Original) The composite gas separation module of Claim 3 wherein the alloy further contains molybdenum.

5. (Original) The composite gas separation module of Claim 1 wherein the intermediate porous metal layer includes palladium.

6. (Original) The composite gas separation module of Claim 5 wherein the intermediate porous metal layer includes palladium and a Group IB metal.

7. (Original) The composite gas separation module of Claim 6 wherein the Group IB metal is silver or copper.

8. (Original) The composite gas separation module of Claim 6 wherein the intermediate porous metal layer includes alternating layers of palladium and the Group IB metal.

9. (Original) The composite gas separation module of Claim 1 wherein the intermediate porous metal layer is at least about 5 microns thick.

10. (Original) The composite gas separation module of Claim 1 wherein the intermediate porous metal layer is about 1 to about 10 microns thick.

11. (Original) The composite gas separation module of Claim 1 wherein the mean pore size of the intermediate porous metal layer is less than the mean pore size of the porous metal substrate.

12. (Original) The composite gas separation module of Claim 1 wherein the intermediate porous metal layer has a top side and a bottom side and wherein the intermediate porous metal layer is directly adjacent to the porous metal substrate on the bottom side and is directly adjacent to the dense hydrogen-selective membrane on the top side.

13. (Original) The composite gas separation module of Claim 1 wherein the dense hydrogen-selective membrane includes palladium or an alloy thereof.

14. (Original) The composite gas separation module of Claim 1 further comprising a layer of a ceramic bonded to the porous metal substrate and underlying the intermediate porous metal layer.

15. (Original) A method for fabricating a composite gas separation module, comprising the steps of:

a) applying an intermediate porous metal layer over a porous metal substrate; and

b) applying a dense hydrogen-selective membrane over the intermediate porous metal layer, thereby forming the composite gas separation module.

16. (Original) The method of Claim 15 further comprising the step of oxidizing the surface of the porous metal substrate prior to applying the intermediate porous metal layer.

17. (Original) The method of Claim 15 further comprising the step of surface activating the porous metal substrate prior to applying the intermediate porous metal layer.

18. (Original) The method of Claim 17 wherein surface activating the porous metal substrate includes seeding the porous metal substrate with nuclei of a hydrogen-selective metal.

19. (Original) The method of Claim 15 wherein the intermediate porous metal layer is applied by electroless plating.

20. (Original) The method of Claim 15 wherein the intermediate porous metal layer includes palladium and a Group IB metal.

21. (Original) The method of Claim 20 wherein the Group IB metal is silver or copper.

22. (Original) The method of Claim 20 wherein the intermediate porous metal layer is applied by depositing alternating layers of palladium and the Group IB metal over the porous metal substrate.

23. (Original) The method of Claim 15 further comprising the step of abrading the surface of the intermediate porous metal layer, thereby forming a polished substrate, prior to application of the dense hydrogen-selective membrane over the intermediate porous metal layer.

24. (Original) The method of Claim 15 further comprising the step of depositing a hydrogen-selective metal on the intermediate porous metal layer, thereby forming a coated substrate and abrading the surface of the coated substrate, thereby forming an polished substrate, prior to application of the dense hydrogen-selective membrane over the intermediate porous metal layer.

25. (Original) The method of Claim 15 wherein applying the dense hydrogen-selective membrane includes depositing palladium, or an alloy thereof, over the intermediate porous metal layer.

26. (Original) The method of Claim 25 wherein the dense hydrogen-selective membrane includes palladium alloyed with at least one of the metals selected from the group consisting of copper, silver, gold, platinum, ruthenium, rhodium, yttrium, cerium and indium.

27. (Original) The method of Claim 15 wherein applying the dense hydrogen-selective membrane includes depositing a hydrogen-selective metal by a method selected from the group consisting of electroless plating, electroplating, thermal deposition, chemical vapor deposition, spray deposition, sputter coating, e-beam evaporation, ion beam evaporation and spray pyrolysis.

28. (Original) A composite gas separation module fabricated by the method of Claim 15.

29. (Original) A method for selectively separating hydrogen gas from a hydrogen gas-containing gaseous stream, comprising the step of:

directing the hydrogen gas-containing gaseous stream to a composite gas separation module, wherein the composite gas separation module includes:

a) a porous metal substrate;

b) an intermediate porous metal layer, wherein the intermediate porous metal layer overlies the porous metal substrate; and

c) a dense hydrogen-selective membrane, wherein the dense hydrogen-selective membrane overlies the intermediate porous metal layer;

whereby hydrogen gas is at least partially partitioned from the gaseous stream by passing through the dense hydrogen-selective membrane.

30. (Original) The method of Claim 29 further comprising the step of reacting hydrogen gas-producing reactants to produce the gaseous stream.

31. (Original) The method of Claim 29 wherein a layer of a ceramic is bonded to the porous metal substrate and underlies the intermediate porous metal layer.

32. (Original) The method of Claim 29 wherein the intermediate porous metal layer includes alternating layers of palladium and a Group IB metal.

33. (Original) The method of Claim 32 wherein the Group IB metal is silver or copper.

34. (Original) The method of Claim 29 wherein the intermediate porous metal layer is about 4 to about 8 microns thick.

35. (Original) The method of Claim 29 wherein the dense hydrogen-selective membrane includes palladium or an alloy thereof.

36. (Currently amended) A hydrogen gas separator, comprising:

a first porous layer made from a hydrogen permeable material; and

a solid layer of ~~said~~ a hydrogen permeable material disposed on said first porous layer and in contact with said first porous layer.

37. (Previously presented) The separator according to Claim 36 further including a porous base layer for supporting said first porous layer.

38. (Previously presented) The separator according to Claim 36 wherein said hydrogen permeable material of said first porous layer and said hydrogen permeable material of said solid layer are the same material.

39. (Currently amended) The separator according to Claim 37 wherein said porous base layer is not comprised of hydrogen permeable material that is selectively permeable to hydrogen gas.

40. (Previously presented) The separator according to Claim 36 wherein said first porous layer has a pore size that varies as a function of distance from said solid layer.

41. (Previously presented) The separator according to Claim 39 further including at least one bonding layer disposed between said porous base layer and said first porous layer.

42. (Previously presented) The separator according to Claim 36 further including a second porous layer made of said hydrogen permeable material, wherein said solid layer of said hydrogen permeable material is interposed between said first porous layer and said second porous layer.

43. (Previously presented) The separator according to Claim 37 wherein said porous base layer is a sintered powder having a predetermined average particle size.

44. (Previously presented) The separator according to Claim 43 wherein said first porous layer is comprised of multiple thick film layers, wherein each of said thick film layers has a different average particle size of said hydrogen permeable material.

45. (Previously presented) The separator according to Claim 36 wherein said solid layer of said hydrogen permeable material is a deposition layer that is deposited onto said first porous layer.

46. (Previously presented) The separator according to Claim 37 wherein said porous base layer is shaped as a tube that defines a central conduit, wherein said first porous layer surrounds said base layer, and said solid layer surrounds said first porous layer.

47. (Currently amended) A method of purifying hydrogen gas, comprising the steps of:

providing a hydrogen permeable structure having a porous layer of hydrogen permeable material ~~covered by~~, said hydrogen permeable material being selectively permeable to hydrogen gas and in contact with a solid layer of a hydrogen permeable material;

exposing said hydrogen permeable structure to a gas containing hydrogen gas; and

causing a pressure differential across the hydrogen permeable structure,

wherein said hydrogen gas permeates through said hydrogen permeable structure and is collected.

48. (Previously presented) The method according to Claim 47 wherein said hydrogen permeable structure is tubular and said step of exposing said hydrogen permeable structure includes passing gas though said hydrogen permeable structure under pressure.

49. (Previously presented) The method according to Claim 47 further including the step of supporting said hydrogen permeable structure with a porous base layer of material.

50. (Previously presented) The method according to Claim 47 wherein said hydrogen permeable material of said porous layer and said hydrogen permeable material of said solid layer are the same material.

51. (Currently amended) A method of manufacturing a hydrogen gas separator, comprising the steps of:

forming a first porous layer from a hydrogen permeable material, said hydrogen permeable material being selectively permeable to hydrogen gas; and

depositing a solid layer of ~~said~~ a hydrogen permeable material ~~over~~ in contact with said porous layer.

52. (Previously presented) The method according to Claim 51 further including the step of forming contours in said solid layer.

53. (Previously presented) The method according to Claim 51 further including the step of forming a second porous layer of said hydrogen permeable material, wherein said solid layer is interposed between said first porous layer and said second porous layer.

54. (Previously presented) The method according to Claim 51 further including the step of forming a porous base layer of material and supporting said first porous layer with said porous base layer.

55. (Previously presented) The method according to Claim 54 further including the step of bonding said first porous layer to said porous base layer.

56. (Currently amended) A hydrogen gas separator, comprising:

a first porous layer made from a first hydrogen permeable material said first hydrogen permeable material being selectively permeable to hydrogen gas; and

a solid layer of a second hydrogen permeable material disposed on said first porous layer and in contact with said first porous layer.

57. (Previously presented) The hydrogen gas separator of Claim 56 wherein the first hydrogen permeable material and the second hydrogen permeable material are the same material.